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RESEARCH MEMORANDUM

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Air Materiel Command, Army Air Forces

FORCE TESTS OF A 1/5-SCALE MODEL OF THE MCDONNELL XP-85 AIRPLANE WITH CONVENTIONAL TAIL ASSEMBLY IN THE LANGLEY FREE-FLIGHT TUNNEL

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SUMMARY

At the request of the Air Materiel Command, Army Air Forces an investigation of the low-speed, power-off stability and control characteristics of the McDonnell XP-85 airplane is being conducted in the Langley free-flight tunnel. The XP-85 airplane is a parasite fighter carried in a bomb bay of the B-36 airplane. As a part of the investigation a few force tests were made on a 1/5-scale model of the XP-85 with a conventional tail assembly installed in place of the original design five-unit tail assembly. The total area of the conventional assembly was approximately 80 percent of the area of the five-unit assembly.

The results of this investigation showed that the conventional tail assembly gave about the same longitudinal stability characteristics as the original configuration and improved the directional and lateral stability.

INTRODUCTION

An investigation of the low-speed, power-off stability and control characteristics of the McDonnell XP-85 airplane is being conducted in the Langley free-fight tunnel at the request of the Air Materiel Command, Army Air Forces. The XP-85 is a jet propelled, parasite fighter designed to be carried in the forward bomb bay of the B-36. In the combat area when the need for fighter escort arises the XP-85 is lowered from the B-36 on a trapeze arrangement and cut loose. When further fighter protection is not required the XP-85 returns to the mother ship and hooks up on the trapeze. The wings are then folded upward and the parasite is drawn up into the bomb bay.

The short fuselage and restricted width of the XP-85 airplane dictated by the size of the bomb bay of the B-36 resulted in a tail design consisting of five units which was investigated on a 1/5-scale model in the Langley free-flight tunnel and reported in reference 1. In order to determine if a less complicated conventional tail would provide the same degree of stability, force tests have been made with a simplified tail without control surfaces in the free-flight tunnel. The results are presented herein and compared with some of the results from reference 1.

SYMBOLS

S wing area, square feet

$\bar{c}$ mean aerodynamic chord, feet

b wing span, feet

q dynamic pressure, pounds per square foot

α angle of attack of fuselage center line, degrees

β angle of sideslip, degrees

ψ angle of yaw, degrees

C_L lift coefficient $\left(\frac{\text{Lift}}{qS}\right)$

C_D drag coefficient $\left(\frac{\text{Drag}}{qS}\right)$

C_m pitching-moment coefficient $\left(\frac{\text{Pitching moment}}{qS\bar{c}}\right)$

C_n yawing-moment coefficient $\left(\frac{\text{Yawing moment}}{qSb}\right)$

C_l rolling-moment coefficient $\left(\frac{\text{Rolling moment}}{qSb}\right)$

C_Y lateral-force coefficient $\left(\frac{\text{Lateral force}}{qS}\right)$

i_t tail incidence, degrees

δ_e elevator deflection, degrees

δ_a aileron deflection, degrees

C_{Y_β} rate of change of lateral force coefficient with angle of sideslip, per degree $\left(\frac{\partial C_Y}{\partial \beta}\right)$

C_{n_β} rate of change of yawing-moment coefficient with angle of sideslip, per degree $\left(\frac{\partial C_n}{\partial \beta}\right)$

C_{l_β} rate of change of rolling-moment coefficient with angle of sideslip, per degree $\left(\frac{\partial C_l}{\partial \beta}\right)$

Subscripts:

U upper

L lower

APPARATUS

Wind Tunnel

The force tests to determine the aerodynamic characteristics of the model were made on the free-flight tunnel six-component balance which is described in reference 2. This balance rotates in yaw with the model so that all forces and moments are measured with respect to the stability axes. The stability axes are a system of axes in which the Z-axis is in the plane of symmetry, perpendicular to the relative wind, and directed downward; the X-axis is in the plane of symmetry perpendicular to the Z-axis and directed forward; and the Y-axis is perpendicular to the plane of symmetry and directed to the right. A sketch showing the positive directions of the forces and moments is given in figure 1.

MODEL

Presented in figure 2 is a three-view drawing of the model. The model used in the present investigation was the same 1/5-scale model used in the investigation reported in reference 1 except that single vertical and horizontal tails were employed instead of the five-unit tail (see fig. 3). The conventional tail assembly had full-scale vertical and horizontal tail areas of 20.1 and 17.9 square feet, respectively, as compared with the total area of 47.5 square feet for the five-unit tail assembly. The stall control vane used in the tests of reference 1 was in place for all tests.

TESTS

The force tests were run at a dynamic pressure of 3.0 pounds per square foot, which corresponds to an airspeed of about 34 miles per hour at standard sea-level conditions and to a test Reynolds number of 302,000 based on the mean aerodynamic chord of 1.03 feet.

All forces and moments are referred to the stability axes originating at a center-of-gravity position of 26.7 percent of the mean aerodynamic chord and located vertically 0.05 percent of the mean aerodynamic chord above the fuselage center line.

RESULTS AND DISCUSSION

The results of the tests made to determine the longitudinal stability characteristics of the 1/5-scale model with the conventional tail assembly are presented in figure 4. Also presented in this figure for comparison are results from reference 1 with the model in the original configuration and with tail off. It can be seen from this figure that the conventional tails gave approximately the same longitudinal stability characteristics as the original design tails. The model with the conventional tail assembly trimmed at a much lower lift coefficient than the original model because of the smaller tail incidence (-5°) and the neutral elevator setting.

Presented in figure 5 is the variation of the lateral stability parameters, C_{Y_β}, C_{n_β} and C_{l_β} with lift coefficient for the model with the conventional tail compared with data from reference 1. The results of figure 5 show that the model with the conventional tail had a higher degree of directional stability over the entire lift range. The directional stability increased with increasing lift coefficient, which is in marked contrast to the results for the original configuration which showed that the directional stability fell off rapidly after $C_L = 0.6$. Because of the elimination of this undesirable characteristic, the conventional tail assembly appears superior to the original configuration from the standpoint of directional stability.

The data of figure 5 show that the conventional tail also increased the positive effective dihedral $-C_{l_\beta}$ up to $C_L = 0.6$ but did not increase the maximum value of effective dihedral over the unstalled lift range. As a result there is only a relatively small variation in the effective dihedral over the lift range which is a desirable characteristic usually not found in a swept wing configuration

CONCLUSIONS

The results of force tests of a conventional tail arrangement having 80 percent of the combined areas of the original five-unit design indicated an equal degree of longitudinal stability and improved directional and lateral stability characteristics.

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2. Shortal, Joseph A., and Osterhout, Clayton J.: Preliminary Stability and Control Tests in the NACA Free-Flight Wind Tunnel and Correlation with Full-Scale Flight Tests. NACA TN No. 810, 1941.

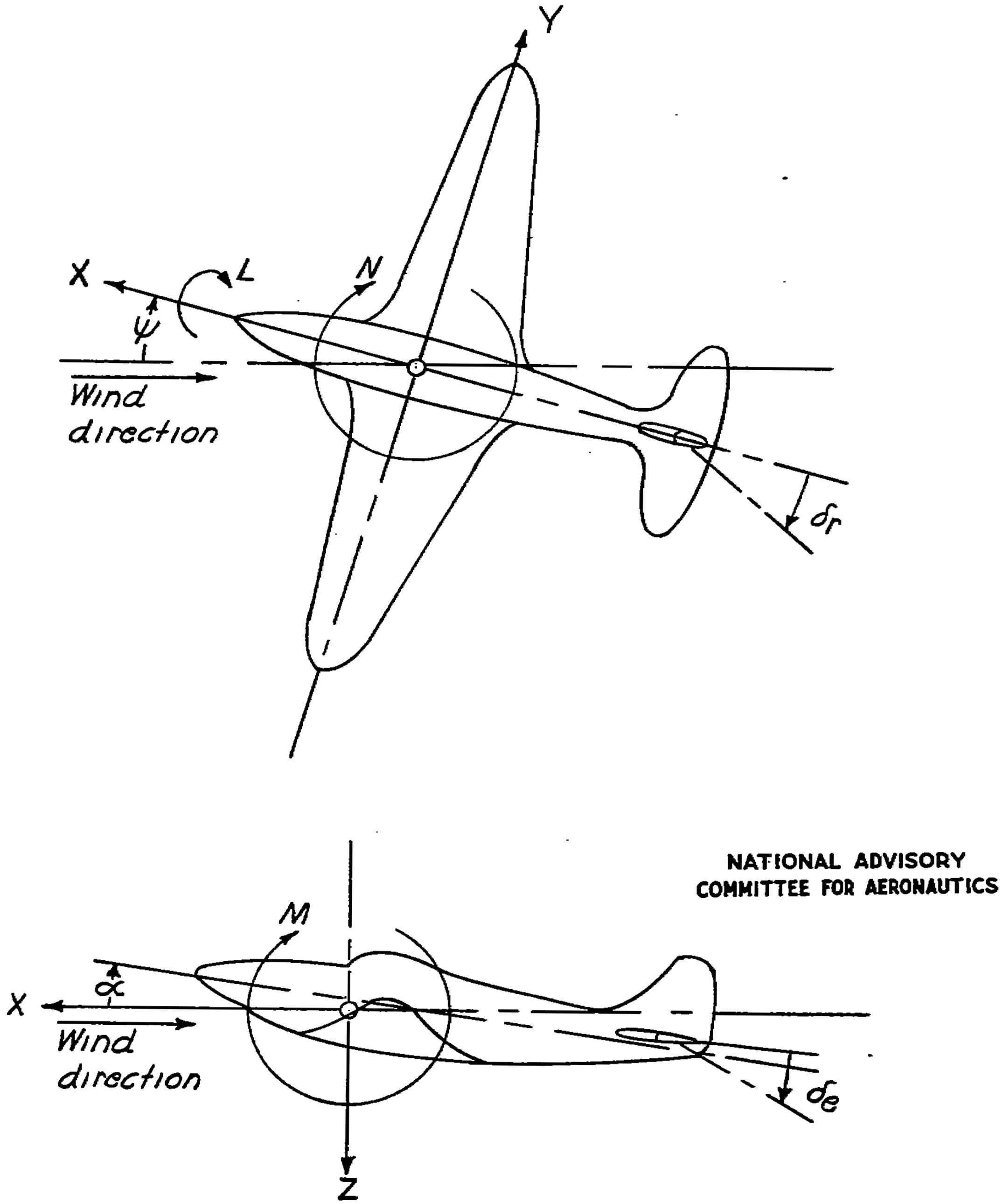

Figure 1. - System of stability axes. Arrows indicate positive directions of moments, forces, and control-surface deflections.

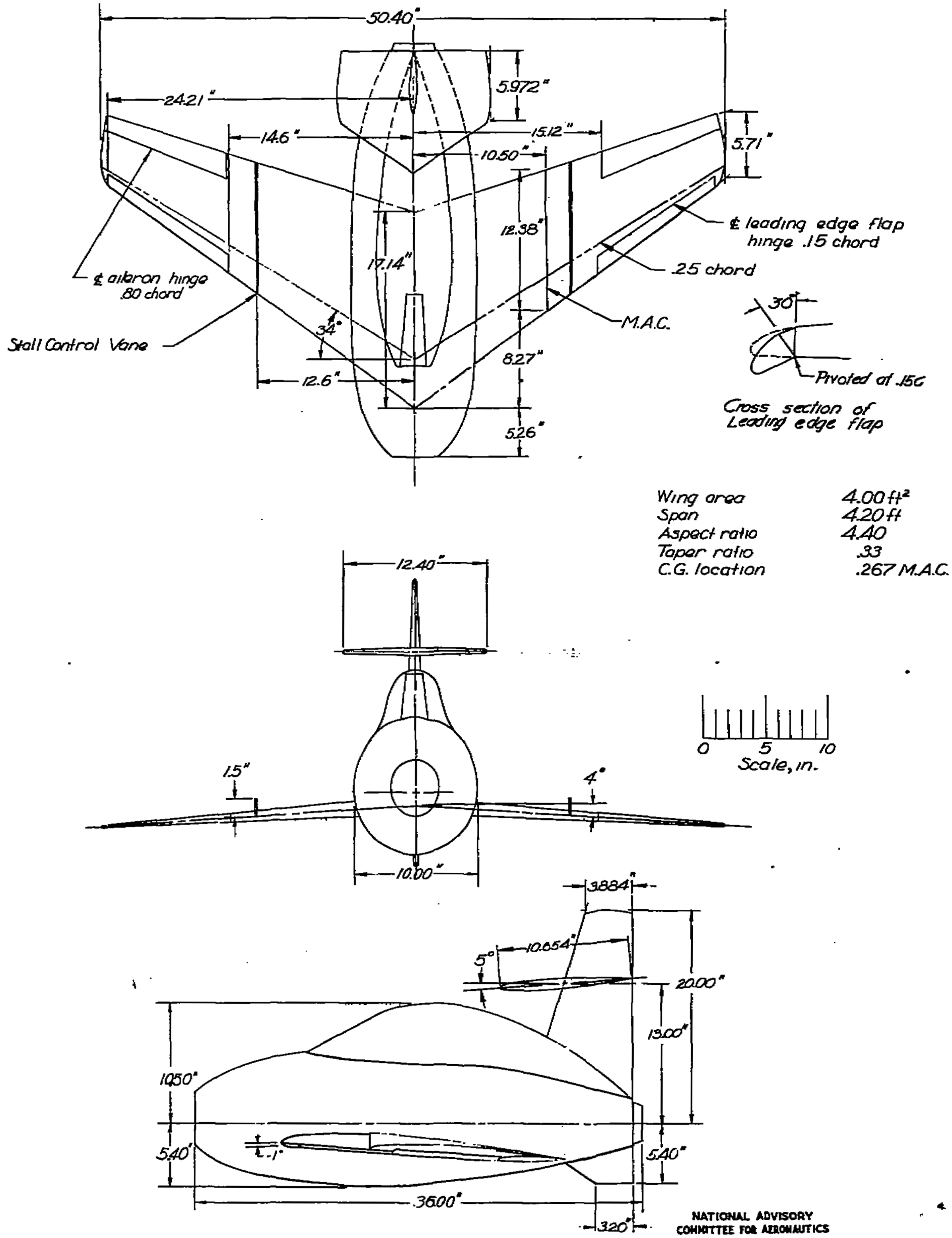

Figure 2.- Three view drawing of the 1/5-scale model of the McDonnell XP-85 tested in the Langley free flight tunnel. Conventional tail assembly.

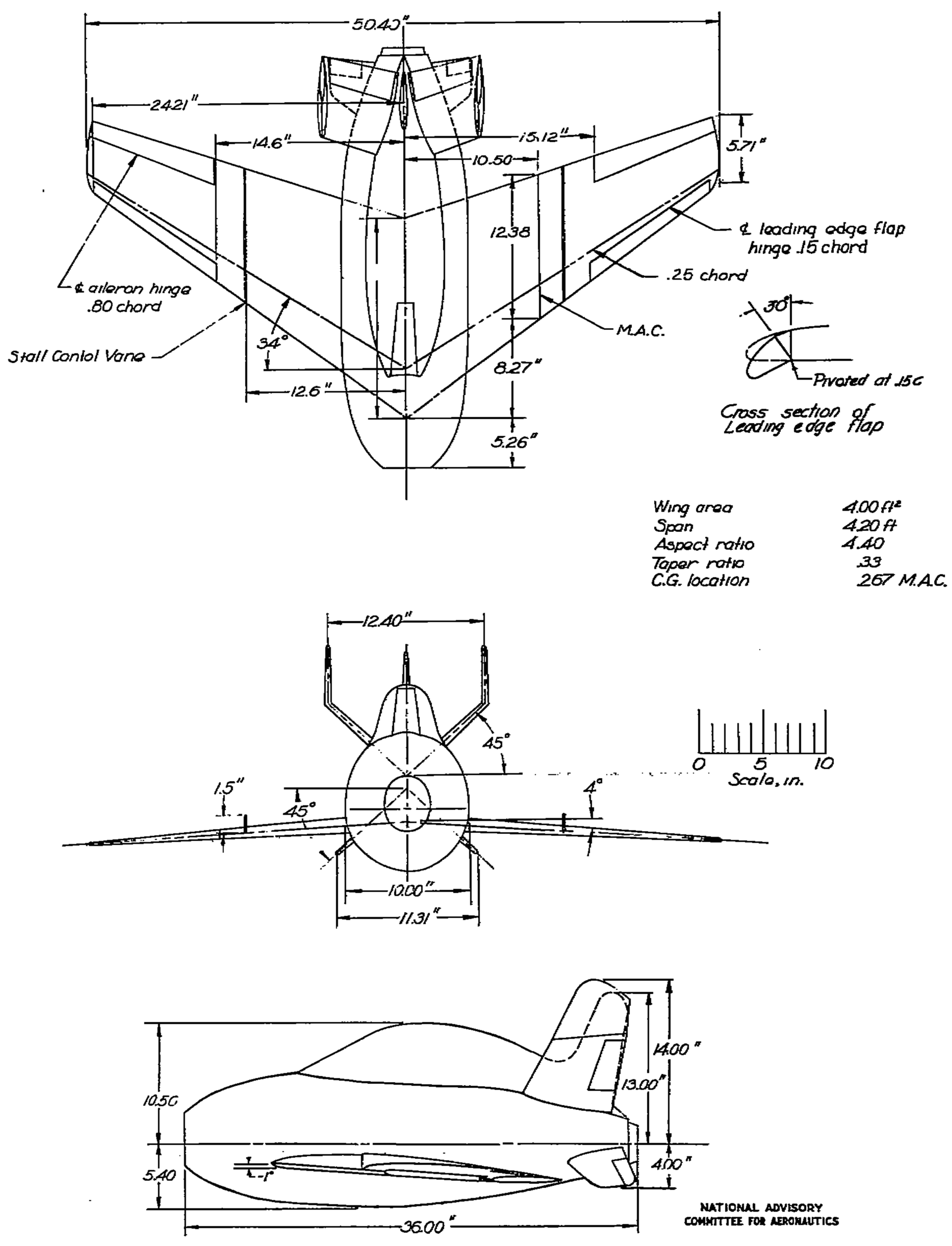

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Figure 3.- Three view drawing of the 1/5-scale model of the McDonnell XP-85 tested in the Langley free flight tunnel. Five unit tail assembly.

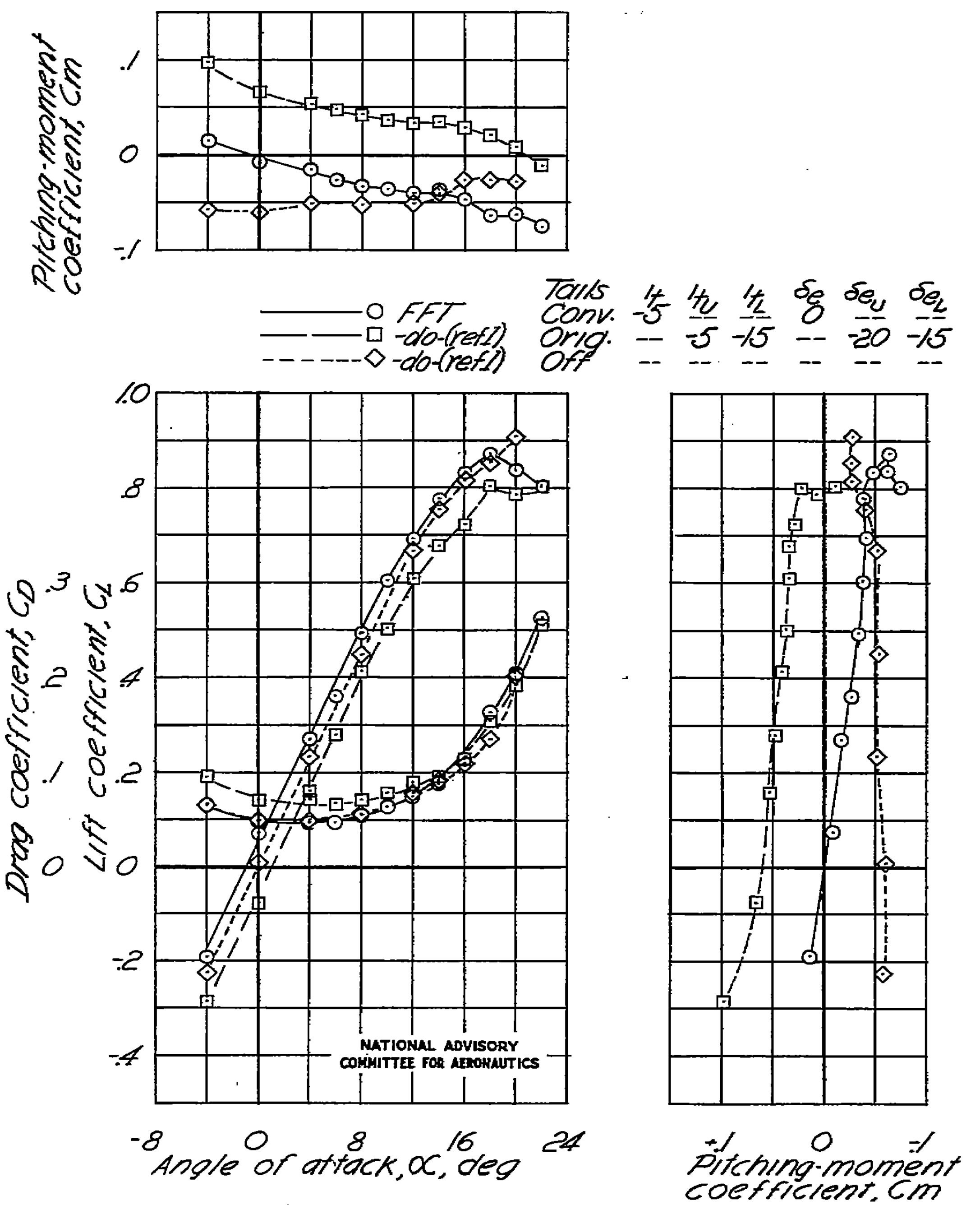

Figure 4.- Lift, drag and pitching-moment characteristics of the 1/5-scale model of the Mc Donnell XP-85 airplane with conventional tail tested in the Langley free-flight tunnel compared with data of reference 1. q = 3.0 pounds per square foot; ψ = 0°; δ_r = 0°; δ_a = -10°. Center-of-gravity location 0.267 MAC. Stall control vane on.

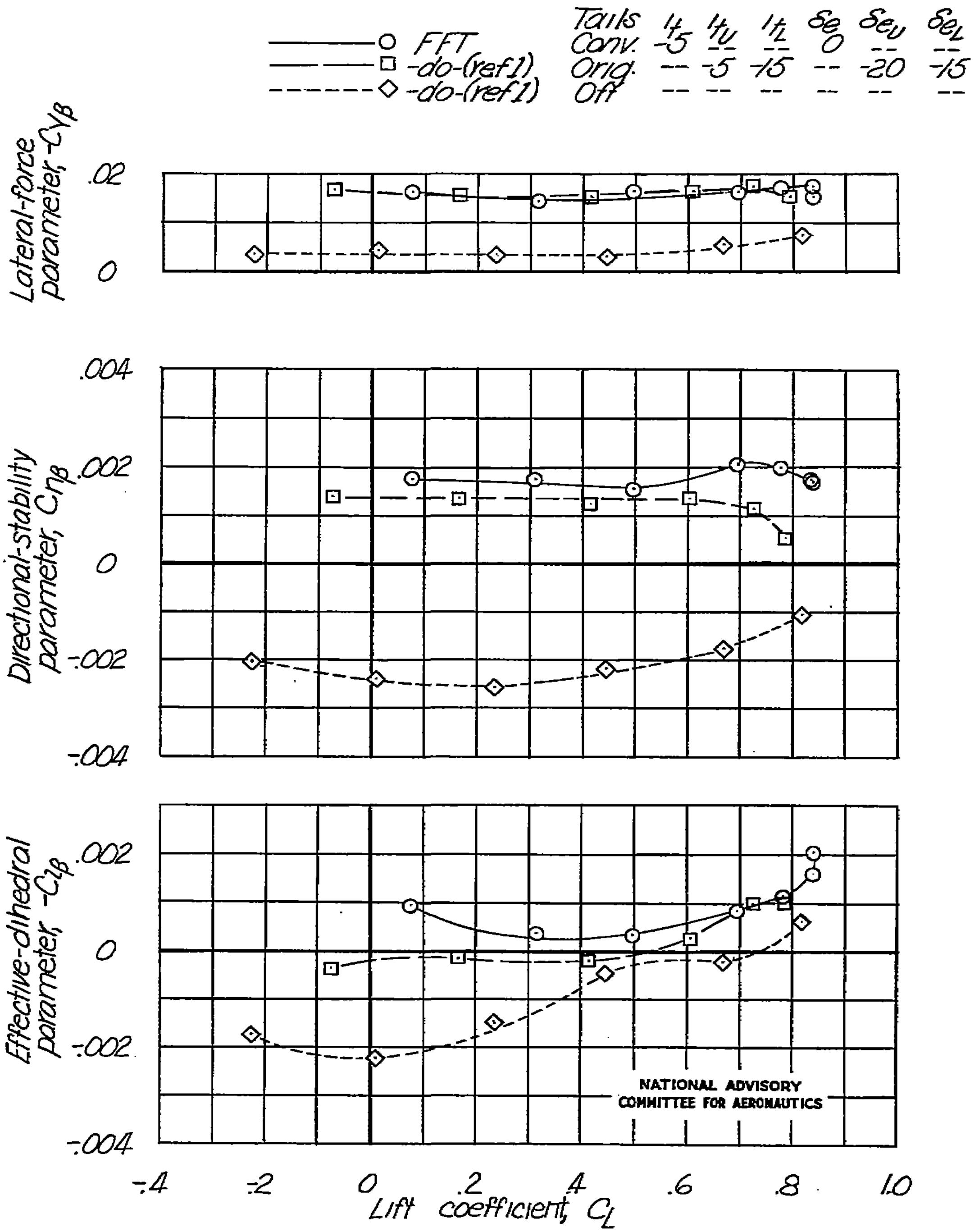

Figure 5.-Lateral stability characteristics of the 1/5-scale model of the McDonnell XP-85 airplane with conventional tail as determined by force tests in the Langley free-flight tunnel compared with data of reference 1. $\delta_r = 0$; $\delta_a = -10°$. Center-of-gravity location 0.267 MAC. Stall control vane on.